Optically Interrogated Thin Film Strain Gauge for Balloon, Phase I

Completed Technology Project (2018 - 2019)

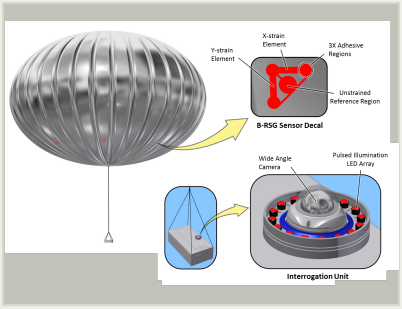
Project Introduction

To support development of atmospheric balloons and gossamer structures, NASA requires a capability for real-time, dynamic strain measurement in thin polymeric membranes during deployment and flight. This capability will provide quantitative test data to inform balloon design efforts, as well as enable real-time monitoring of material state during flight. Existing technologies include wired or wireless electrical or fiber-optic strain gauges, impractical to implement on a thin membrane; photogrammetric techniques that require multiple cameras, detailed knowledge of nominal balloon geometry, and significant post-processing computation; and exotic optical techniques that are unsuited for large scale, dynamic balloon testing and flight. We will develop a completely novel measurement system based on an optically-interrogated thin-film elastomer strain gauge that will provide sensitive, real-time, two-component strain measurement in balloon gores. A large number of the low modulus, thin-film sensors distributed across the balloon will be interrogated remotely at high frequency with a single camera that can be mounted on the payload.

Anticipated Benefits

Given the high cost of payload launch, NASA often develops lightweight technologies. These include membrane systems such as balloons, solar sails, inflatable booms, and parachutes, along with thin structures such as solar panels, spacecraft skins, and pressure domes. In each case, our novel low modulus, remotely interrogated strain gauge will be of value for both testing and development along with in-service control feedback and health monitoring.

Because of its unique properties such as low elastic modulus, ease of application, and remote interrogation, we anticipate that this novel sensor will have a broad array of applications. It will find commercial use in testing of flexible structures such as sails, balloons, tents, and architectural panels. It might also be used in novel scientific applications, such as measuring the strain in human skin during locomotion or tree limbs under wind load.



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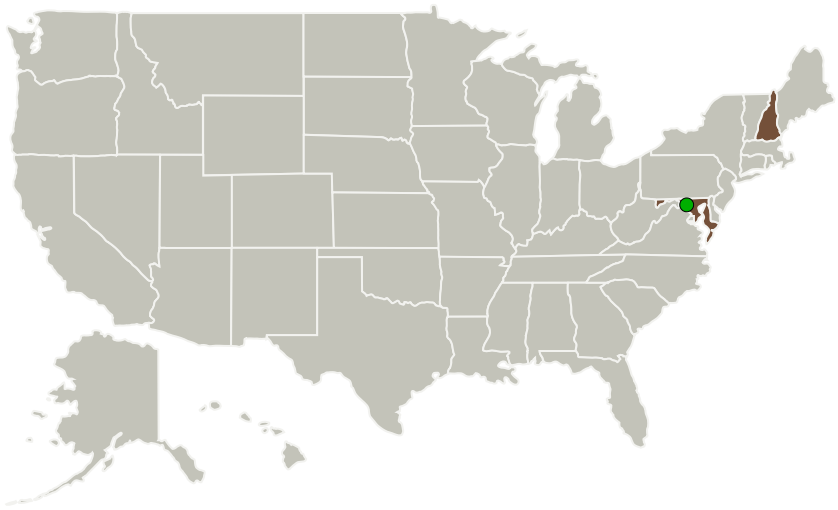
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Creare LLC	Lead Organization	Industry	Hanover, New Hampshire
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Maryland	New Hampshire

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137878)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Creare LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

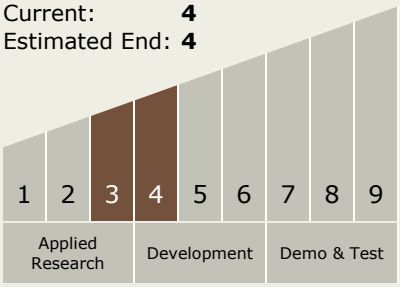
Carlos Torrez

Principal Investigator:

Marc Ramsey

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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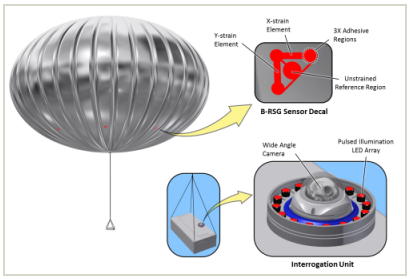
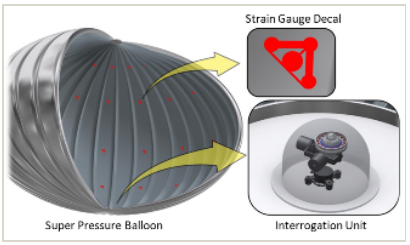
Images



Briefing Chart Image
Optically Interrogated Thin Film Strain Gauge for Balloon, Phase I
(https://techport.nasa.gov/image/129038)



Final Summary Chart Image
Optically Interrogated Thin Film Strain Gauge for Balloon, Phase I
(https://techport.nasa.gov/image/129604)

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.1 Materials
    - TX12.1.3 Flexible Material Systems

Target Destination

Earth